AUTHORIZING CONSTRUCTION FOR THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

HEARING

BEFORE THE

SELECT COMMITTEE ON ASTRONAUTICS AND SPACE EXPLORATION

EIGHTY-FIFTH CONGRESS

SECOND SESSION

ON

H. R. 13619

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SELECT COMMITTEE ON ASTRONAUTICS AND SPACE EXPLORATION

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FRIDAY, AUGUST 1, 1958

HOUSE OF REPRESENTATIVES,
SELECT COMMITTEE ON ASTRONAUTICS
AND SPACE EXPLORATION,
Washington, D. C.

The committee met at 2:30 p. m., pursuant to notice, in room F–18, the Capitol, Hon. Overton Brooks, presiding.

Present: Representatives McCormack, Brooks, O'Brien, Metcalf, Natcher, Sisk, Martin, Arends, McDonough, Fulton, and Ford.

Present also: Dr. Charles S. Sheldon II, assistant director; Raymond Wilcove, Director of Research; Richard P. Hines, committee clerk; and Harney S. Bogan, Jr., Counsel.

Mr. BROOKS (presiding). The committee will please come to order.

H. R. 13619 will be made a part of the record at this point.

(The bill referred to follows:)

[H. R. 13619, 85th Cong., 2d sess.]

A BILL To authorize appropriations to the National Aeronautics and Space Administration for construction and other purposes

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there is hereby authorized to be appropriated to the National Aeronautics and Space Administration the sum of $47,800,000 for acquisition or condemnation of real property, for plant and facility acquisition, construction, or expansion, and for other items of a capital nature as follows:

Pilotless aircraft station, Wallops Island, Virginia: Additional launching facilities; range control and administration building; shop and laboratory facilities; roads, causeway, bridges, seawall, and appurtenances; utilities; equipment and instrumentation; and approximately three thousand four hundred acres of land, $24,500,000.

Space projects center, vicinity of Washington, District of Columbia: Space projects building; research projects laboratory; roads and appurtenances; utilities; equipment and instrumentation, $3,750,000.

Various locations: Equipment and instrumentation, $19,550,000.

SEC. 2. Any of the amounts enumerated in section 1 of this Act may, in the discretion of the Administrator of the National Aeronautics and Space Administration, be varied upward 5 per centum to meet unusual cost variations, but the total cost of all work so enumerated shall not exceed $47,800,000.

Mr. BROOKS. Mr. McCormack, the chairman, stated that he might be late. He asked me to come in and proceed today with the hearing.

We have before us today H. R. 13619, by Mr. McCormack, which has just been introduced, a bill to authorize appropriations to the National Aeronautics and Space Administration for construction, and other purposes.

Now, we have several witnesses here today. I think our first witness is Dr. Hugh L. Dryden, Director of NACA; is that correct?

Dr. DRYDEN. That is still correct.

Mr. BROOKS. There is a period of 90 days' transition.

Dr. DRYDEN. The Administrator has not yet been nominated. NACA is still in existence until the Administrator declares NASA in operation.

Mr. BROOKS. Doctor, you have a prepared statement, and I think you also have something you want to say about the budget. I would suppose that everyone wanted to hear a little bit about the budget anyway.

STATEMENTS OF DR. HUGH L. DRYDEN, DIRECTOR; DR. PAUL G. DEMBLING, GENERAL COUNSEL; RALPH E. ULMER, BUDGET OFFICER; WILLIAM O'SULLIVAN, ROBERT GILRUTH, AND EDGAR CORTRIGHT; NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

Dr. DRYDEN. Mr. Chairman, I have no detailed prepared statement. It did occur to me that you would be able to consider the capital items more intelligently if you had a little bit of the story on the whole proposed budget of the new agency and not just this particular part of the budget.

As you know, the law which you gentlemen had a lot to do with requires that capital items of a value more than $250,000 be authorized before the appropriations can be considered.

I want to express my great appreciation for the promptness with which you are holding this hearing because to my mind it would be a great tragedy if the new agency had to wait until the Congress came back again before it could get into operation.

As of the moment, of course, no money has been appropriated directly to NASA. The President has sent to the Congress a supplemental estimate, for the initial appropriations of the National Aeronautics and Space Administration in the amount of $125 million new appropriation, and he has stated that $117 million additional is being transferred from the Department of Defense.

You will recall that the Department of Defense under the law at the present time, at least before the National Aeronautics and Space Act was passed, had the responsibility for civil space programs as well as military, a responsibility which lasts for 1 year, until February of 1959.

The act reorganizing the Defense Department rephrases that temporary authority, putting it in the Department of Defense rather than specifically in the Advanced Research Projects Agency.

So that in this interim period pending establishment of the National Aeronautics and Space Administration, the civil programs have been carried on under funds appropriated to the Department of Defense in their appropriation act.

The NACA has been consulted on all obligations which have been made so far. The procedures have required our concurrence.

Now, with the establishment of this agency, the President is transferring $117 million of a total sum of something more than $500 million—I don't remember the exact figure appropriated in the

Department of Defense bill to the Advanced Research Projects Agency.

I am not sure whether you have passed the Defense bill yet, or not. It is the pending bill which carries something more than $500 million for the Advanced Research Projects Agency.

Where in detail specificially the $117 million comes from, I am not prepared to tell you now except that the greater part of it comes from the appropriation to ARPA and possibly a very much smaller amount from certain programs in the Air Force appropriation.

So that, essentially, all that I can tell you is the total number of dollars to be transferred from Defense.

So we are supporting a program of obligational authority of $242 million total, of which $117 million comes by transfer from Defense, and $125 million is before the Congress for new appropriation.

As I understand the procedure, it was transmitted to the Congress and the Senate is proposing to include it in a supplemental bill, which is now before the Senate.

That bill originated in the House. Presumably the House will hold hearings on the appropriations in connection with agreeing to their conference report.

Most of this $242 million, namely, $187 million, under the heading of research and development which, as you recall from the act you passed, is no-year money, will be expended outside the agency by contracts with universities, with industry, or by utilizing facilities of the military services.

$47.8 million is for capital items, construction and equipment, which is before you today for authorization, and only $7 million of the $242 million is to be used for about 800 additional personnel within the new agency. Their prime function is to manage this large expenditure and to carry on those activities relating to the tracking networks, collection of scientific data that it is essential to centralize.

Now, as I remarked at the beginning, I think it would help you to have us give you about a half hour presentation of what the program of the agency is, talking about the whole thing rather than just about the $47.8 million.

I would like then to ask Mr. O'Sullivan to begin by talking about the space science part of the program of the new agency.

The CHAIRMAN (Mr. McCormack). Do any of the members want to ask Dr. Dryden any questions?

Dr. DRYDEN. I will be talking later again.

The CHAIRMAN. I know, but we have you now.

Dr. DRYDEN. I will be here.

Mr. FULTON. Why are the facilities being put in Washington, D. C.? Is there not getting to be too much of a concentration here, too much vital equipment?

Dr. DRYDEN. There is nothing in Washington, D. C., sir, I would prefer to defend the facilities budget after you get a picture of what the program is, but if you would rather talk to the $47.8 million right now, I will be glad to do it.

Mr. FULTON. On page 2, line 3, of the bill, H. R. 13619, I will refer your attention to it later.

Dr. DRYDEN. The vicinity of Washington, but not Washington, D. C.

This chart shows a breakdown of the total program. It includes a program in space science which is the continuation of the kind of

scientific satellite experiments conducted at the moment by Explorer IV, which was put up a few days ago.

It includes a program in space technology which is essentially laying the groundwork for doing bigger and better things in the future. In this are such items as the million-pound rocket engine which we have talked about a good bit. We will have a detailed presentation on that.

There is certain work on the application of satellites in the field, meteorology and communications.

Next there is a program called here "technology of manned space flight vehicles." This is a program that leads eventually to manned orbital flight about the earth.

I mentioned the $47.8 million for capital expenditures. The chart thus shows the breakdown of the $242 million.

The CHAIRMAN. You are only asking for the $47.8 million now?

Dr. DRYDEN. This is the only part that requires authorization.

As I understand it, your committee is not hearing the appropriation request, but I wanted to give you the appropriation story so that you have a background to act on the capital items.

Mr. McDONOUGH. Just a matter of information.

Dr. DRYDEN. The presentation is an information briefing to you; yes, sir.

Mr. McDONOUGH. On the space technology of $82 million, that you have and you are operating with?

Dr. DRYDEN. None of this money we have; $117 million is to come by transfer from Defense; $125 million will be before your Appropriations Committee.

Mr. McDONOUGH. Then a further question: All that you have on that chart is not confined to the vicinity of Washington or Wallops Island?

Dr. DRYDEN. No; most of the work is to be done by contract. This is the total broad program.

Mr. FULTON. In that budget are there contained any items of research for chemical, including hypergolic fuels or nuclear fuels?

Dr. DRYDEN. We have this covered in the presentations to be made. There is included support of the Rover program, which has previously been supported by the Air Force. There is also work on high energy fuels. All of this is covered in our presentation.

Mr. O'SULLIVAN. Mr. Chairman and members of the committee, the newly formed National Aeronautics and Space Administration has already formulated a rather firm program, but not completely finalized, that covers the phase of the work that involves unmanned earth satellites, lunar probes, and supporting vertical probes or sounding rockets as they are usually called.

This program in accordance with the purpose and intent for which you have established the NASA takes into consideration four major factors:

First, the United States IGY satellite program;

Second, the Department of Defense scientific space flight program;

Third, the potential satellite launching vehicles of the near future; and

Fourth, scientific experiments proposed by the scientific community of our Nation.

This first chart very briefly summarizes the International Geophysical Year program of the earth satellites of the United States.

Here are listed the various satellites.

When we examine this program in detail we note several factors. First, the experiments themselves are of two general types. First, is the environmental type which is aimed at learning how to make an earth satellite work.

An example of that is how to control the temperature of the satellite when in space so that, say, its telemeter does not get either too hot or too cold and thus unable to function and send back the data being obtained.

The second general type of experiment that is being carried on includes those which are exploratory, initial type of experiments, relevant to the conditions that are found in space such as cosmic rays, solar ultraviolet radiation, and the like.

When we look then at this program with respect to its intensity we find, also, that there are many experiments that have not so much as been touched upon. This has been due in large measure to the newness of the type of work and in particular the very limited payloads that our satellites have been able to carry, a payload of about 20 pounds.

Finally, when we consider the schedule on which this program is being carried out we note that it essentially terminates about the end of this year.

In the next chart we have very briefly outlined the present Department of Defense scientific space flight program, in particular that which is established and is in that portion of the Department of Defense known as ARPA, the Advanced Research Projects Agency.

When we examine this program in detail we find, first, with regard to it that it embraces two types of work, satellites and lunar probes.

The lunar probes, like the IGY satellites, are of an initial exploratory character and many new things have to be found out about how to make them work and then to conduct with them initial types of experiments to explore the space between here and the moon and to some extent the moon itself.

With regard to the satellites in this program we note that the experiments that they contain are in essence an extension, the next step, with respect only to a few of the experiments that have been conducted in the IGY program. Only a few new experiments have been added.

When we consider the scope of the work that is being done here, we find that it leaves out many experiments that should now be started.

The schedule essentially terminates about the middle of 1959.

The third point that we have considered includes the potential satellite and lunar-probe vehicles that we can look to in the near future in performing a continuing logical program.

The general result is that within the next year to year and a half, we can anticipate the availability of vehicles capable of carrying the earth satellites into orbits of 300 miles, possibly more, using payloads of satellites weighing in the range of from 100 to 700 pounds.

To look toward the future we must now begin preparation for still heavier weights.

The CHAIRMAN. If members have any questions to ask Mr. O'Sullivan as he goes along I think you ought to ask them.

Mr. McDONOUGH. Mr. O'Sullivan, on that chart as you outline these things, how many of those things are to a point of practical application or are they in the theoretical stage?

Will you point out those that are up to the point of practical application?

Mr. O'SULLIVAN. Those in the first two charts are already approved and tentatively scheduled. Some of these are very light-weight satellites—the Naval Ordnance Test Station air-launched satellites are ready for flying. In fact, an initial launching has already been attempted.

Of the Juno I satellites, one was launched the other day—that was Explorer IV. Of the Thor-Able lunar probes, none has yet been launched. The time scale is of the order of about 6 to 9 months from now, possibly a little longer.

Mr. McDONOUGH. That has nothing to do with the so-called publicized statement that we are going to shoot the moon this month.

Dr. DRYDEN. No comment on this in open session.

Mr. O'SULLIVAN. The Juno II lunar probes are another approach to the same problem, a backup in that sense or Thor-Able is a backup for Juno II lunar probe, whichever way you want to look at it. The Juno II satellite is essentially an immediate endeavor to apply the initial type of experiments that have been carried in the IGY earth satellite. They have been refined to make them so that they yield more of the kind of information that we urgently need.

Mr. McDONOUGH. Those that we have not put into space are of a more highly specialized type of satellite that will give us more information than those we have already shot?

Mr. O'SULLIVAN. That is correct, sir.

Mr. McDONOUGH. Of those, you mention the Thor-Able lunar probes and Juno II satellite. Those have not been shot yet.

Mr. O'SULLIVAN. They are already scheduled.

Mr. McDONOUGH. I appreciate your remarks but the press has more information that the committee.

Mr. O'SULLIVAN. I would rather not discuss this matter in open session.

Mr. SISK. You mentioned about the weights to be expected, say 100 to 700 pounds at about 300 miles. Are you referring to the perigee?

Mr. O'SULLIVAN. This would be the altitude for a circular orbit of equivalent energy, that is, it took a booster of equivalent energy to put it into that orbit.

Mr. FULTON. Would you compare the level of these programs as to type and kind with the similar status of the Soviet programs along these lines? Where does the United States stand in its planning as you have pointed out compared to the Soviets' programs?

Dr. DRYDEN. I think perhaps I ought to answer that. As you know, the Soviets have put up a satellite weighing 2,900 pounds. It is going to be some years before we are able to do that if you are measuring the relative performance simply by the gross weight. This is where such things as larger boosters come into the picture. The weights that O'Sullivan is talking about are those which come out of the current missile booster developments, the Atlas and Titan.

Mr. FULTON. Of what degree of thrust are you speaking then for these programs of the United States, several hundred thousand pounds, half a million pounds, or what?

Dr. DRYDEN. Essentially the thrust of the Atlas or the Titan, a few hundred thousand pounds.

Mr. FULTON. On the basis of certain scientific programs, we know what the Soviets have had, and what we have done. Would you comment generally as to what the status of our scientific advance is on these programs that you are planning, compared to the Soviets? I think we need an estimate of that for the public.

Dr. DRYDEN. At the present time the International IGY Committee is meeting in Moscow. I read in the paper this morning—I have had no private news—that the Soviets have given a report on the cosmic ray measurements made in Sputniks 2 and 3. They have confirmed and shown some diagrams of the existence of the belt of radiation which we discovered using one of the Explorers, a fact unknown before, a factor which is going to have to be considered in any manned space flight because the radiation dose is high enough that some steps will have to be taken. So the Soviets know about the same phenomena that we do. There is a little intimation that they got it on Sputnik 2. Whether they got it on Sputnik 2 or 3, I don't know.

Scientifically I would say the knowledge of density of matter in space and of cosmic rays is roughly equal. They may be slightly ahead because they have more apparatus in Sputnik 3.

Mr. FULTON. So you would say this total planning will put us ahead scientifically of the Soviet Union in their program in the same period.

Dr. DRYDEN. I think so. The difference is that the Soviets need a fewer number of satellites because they put much more scientific equipment in 2,900 pounds than you can in 700 pounds. Roughly it takes us 4 or 5 satellites to do the same scientific job that they could do in 1, assuming that the experiments are of such a type that the 5 do not interfere with each other. You have to choose the kinds of experiments you can do together so as not to get mutual interference.

Mr. FULTON. You would say this program is no attempt to leapfrog the Soviets' plans to get ahead of them?

Dr. DRYDEN. In all honesty, I would have to say that the prospective space programs are not such as to leapfrog the Soviets immediately, or very soon.

Mr. FULTON. Thank you.

Mr. BROOKS. Is this an attempt to catch up with the Soviets' program?

Dr. DRYDEN. This is an attempt to establish a national program for the United States. It starts at a beginning which I think is adequate. It most decidedly is not a crash program to catch up with anybody. It is to start on doing the things we think ought to be done to establish a space program. You have to learn more about the environment of space. You have to lay the grouud work, the technology that enables you to put bigger loads into space. You have to think about the problems of putting man into space flight. This is a program that begins that.

Mr. BROOKS. As I understand it, you mean this is not in any sense competitive with the Soviet program and as you make advances you do not check the advances as against the Soviet program?

Dr. DRYDEN. I would say that this program is not at a level at which we could guarantee to do that; that is correct.

Mr. BROOKS. May I ask you this: Since we have had the regular meetings which were adjourned some weeks ago, is there any evidence

that the Soviets are giving us the information, the full information which was promised us under the IGY program?

Dr. DRYDEN. As I mentioned, according to newspaper reports they are presenting very technical scientific papers to a meeting of the International Committee on the Geophysical Year in Moscow this week.

Mr. BROOKS. Are we giving the world the benefit of our attainments in that respect?

Dr. DRYDEN. Yes.

Mr. BROOKS. The Soviets gave us that about radiation. Have they given us other data that we otherwise would not have been aware of?

Dr. DRYDEN. They gave us some information about the heart rate of the dog. When he was fired there was a very great increase.

Mr. BROOKS. Did we give them any information about the heart rate of the mouse?

Dr. DRYDEN. Not as yet, I think. There was information received, as I understand it, by telemeter, but I am not familiar with the results, but undoubtedly it will be made available.

Mr. BROOKS. Can I ask you this, while you are here, on the Thor-Able lunar probe. Really the present program of the ICBM is a forerunner of the Thor-Able lunar probe program; is it not?

Dr. DRYDEN. The present space program and everything we talked about here rests on the big boosters of the missile program. It is not until you develop something new in 4 or 5 years that you get beyond that. Now there are upper stages that are new, there are combinations that are new, but the one that is at the bottom of the pile, the biggest thrust is one of those now in our ballistic-missile programs. For this program it will be necessary to have additional boosters made.

In order words, they will not be diverted from the ballistic-missile program, but the companies which are making boosters for the ballistic-program will be asked to build additional boosters for the space program.

Mr. BROOKS. One more question, Mr. Chairman:

We have given a certain amount of data in the radiation field in the upper stratosphere or space. Since all of this is going to be public, do we have any additional information that we have not given to the press?

Dr. DRYDEN. I would say that in general the press can deal only with the very gross and general aspects. Let me say first that our first experiments were ones in which we simply detected the presence of this field. Explorer 4 is carrying more sophisticated instruments, as the scientists call them, to learn more about the nature and character of the radiation. I think even if this were published in the press it would be meaningless to the average reader. I do not know whether I make myself clear, but there is a great deal of detailed scientific data that no newspaper would publish because it is not of any interest to the readers. So the press is simply given an overall view—there is radiation of high enough dosage to mean you have to do some shielding if you are going to put a man up there very long in that particular section of space.

Mr. FULTON. If this program is not aimed at keeping up with the Soviet Union and being competitive with her in the space program

that we do get even with the Soviet Union on these scientific developments?

What is that figure? Some of us want just to do that.

Dr. DRYDEN. I personally would not ask for any more at this moment. This is a beginning figure.

The CHAIRMAN. His question was how much more would be needed.

Dr. DRYDEN. I think the level will rise to something twice or perhaps more, but I would not advise you to appropriate that money now because I don't think we are in a position to utilize it effectively now. This is a beginning new agency. We have had no national program other than the IGY program, which is a very limited program. You have to build this up, and it does not help doing that by throwing around a lot of money to everybody.

Mr. FULTON. That is not quite my point.

Dr. DRYDEN. If you are going to keep up with the Soviets you will be appropriating certainly twice as much eventually.

Now, remember, the total space program, including the military program, is about $550 million, as I remember it. A large part of this is in the reconnaissance satellite, the military satellite program. So at present you are on a total scale of about a half billion dollars a year.

Mr. FULTON. What in your view, not for appropriation now, but what in your view is necessary in money for us to catch up to the Soviet Union competitively in the space field? How do we do that? You see, you put this in a context of not being competitive with the Soviet Union. Some of us would like to be competitive.

Dr. DRYDEN. May I say the space program is not the only program of interest to the security of the country. At the present time the ballistic missile program has the highest priority and I, myself, as well as other people, am more concerned with whether we have a stock of missiles ready to operate intercontinentally than I am about doubling or tripling this amount of money in the space program at the present time. I think that it must be clear that the military applications of the program in space are very dimly seen at the present time. We are all confident that there will be a lot of military application to space, but if somebody asks you to start on a space weapons system to defend the country or to carry an offensive against the Soviet Union we would not know how to do it intelligently at this moment.

Mr. FORD. Do I detect the view that if you greatly went beyond this funding program which was to be reflected in personnel and facilities that there might be some impact on the military program at the present time?

Dr. DRYDEN. That is what I am trying to say. As I understand the picture, the country is faced with a deficit next year of some $10 billion. This puts the pressure on you to examine what it is sensible to do. Now I am for extensive support of the space program. Don't misunderstand me. That is the job I have. I don't have the intercontinental missile job except in a supporting way through our research activities. But this budget was worked out by discussions. I think it is a reasonable budget to start the new agency. It will enable us to get a program going. We cannot do very much about some of these things until we have larger boosters, and no amount of money that you appropriate now will get those earlier than about 3 or 4 years.

Mr. McDONOUGH. Mr. Chairman. Am I correct in believing that you are informing the committee that we are building on a firm

foundation for space science; we should not now at this time appropriate funds that we cannot fully digest insofar as the scientific facts are concerned, which would weaken our foundation rather than strengthen it?

Dr. DRYDEN. Yes.

Mr. McDONOUGH. Now, the other point that I see—I am not too concerned about being spectacularly competitive with the Soviet Union. I don't think we ought to fire off skyrockets just to tell the world that we are ahead of the Soviet Union. I believe that if we build slowly but surely in the direction of science and spread that information throughout the world we will be doing a greater service than if we attempt to leapfrog the Soviets. I do not think they have anything now, and I am not saying this from any knowledge that I have, but my own intuition is that I don't think they have now anything that we cannot have very soon.

The thing that I think we need to do more than anything else is to provide means for the proper fuels and the proper rocket engines in order to to put these satellites up, and this is going to take time.

Dr. DRYDEN. That will take time. May I say it another way. There are many projects proposed. I do not know of any that cost less than about a hundred million dollars including all the costs. They usually include a considerable element of gamble as to whether they will come through. If the position were different, if we had unlimited money we might want to take a lot of those gambles to jump ahead, as you say. I think we have to steer a middle course. We must not say we are going to wait until all the research is done and all the risk is out before we work in space. You would never get anything done. On the other hand, I would not be in favor of taking half of this budget and putting it into a single space project which would not have a good chance of working. I don't think that a hundred million dollars is so freely available as to warrant that kind of gambling.

Mr. FULTON. You see, this shows the basic difference in philosophy in the approach to space. For example, from my point of view when the Soviet Union is able to put up and has put up a 2,900 pound vehicle, that is a vehicle that is capable of carrying a man and becoming a manned satellite for either peacetime or wartime use. That is a tremendous danger to the United States.

It likewise makes me question whether if it is going to take us several years just to get up to 700 pounds into space——

Dr. DRYDEN. One year. This is in sight.

Mr. FULTON. Well, within 1 year, but several years to get up maybe to a thousand pounds, whether we are going too slowly for our defense.

Dr. DRYDEN. It will not take several years to get a thousand pounds.

Mr. BROOKS. Didn't I understand you to say that it would take 5 or 6 years to get a 2,900-pound satellite into space?

Dr. DRYDEN. I did not say it quite that way. I said it would take 4 or 5 years to get this million-pound or million-and-a-half pound engine which would enable us to go beyond the 2,900 pounds.

Mr. BROOKS. It would take us at least that long to catch up with the Soviets.

Mr. FULTON. In the meantime the Russians can have a manned satellite.

Dr. DRYDEN. They don't have a manned satellite.

Mr. FULTON. By which they could make reconnaissance of everything we have.

Dr. DRYDEN. They do not have a manned satellite. There is a lot more to a manned satellite than putting 2,900 pounds up in the air, quite a lot more.

The CHAIRMAN. Will you explain that instead of trying to laugh it off? These members are asking serious questions.

Dr. DRYDEN. In the first place, you have to get him back again. I don't think you want to put him up and not get him back safely.

The CHAIRMAN. How far have the Soviets advanced in that? You can argue all you want. It is a relative situation.

Dr. DRYDEN. We know the Soviets can put 2,900 pounds in the air. This does not solve the problems of manned flight. You must get your 2,900 pounds back, you must be sure that the reliability of your launching vehicles is such that you have better than a 50-50 chance that he gets off the ground in the first place. You have some difficult problems. You are going to hear some of this later on, by the way, as to what the problems are of getting man into space. This program that we are talking about will lead to a man in space in something of the order of 2 to 3 years, depending on how much luck you have with it.

Mr. McDONOUGH. Do we know whether it was a 2,900 pound satellite the Soviets put up? We have weighed it?

Dr. DRYDEN. We have not weighed it but there is no reason to doubt it.

Mr. ARENDS. No reason to believe it, either.

Dr. DRYDEN. Yes, there are some reasons to believe it because we have photographed the satellite. We know how big it is and so on.

Mr. McDONOUGH. Are we able to detect what the satellite contains?

Dr. DRYDEN. They have published pictures of what it contains.

Mr. McDONOUGH. Does your staff know that the material that it contains is of much more value to them insofar as actually giving them information rather than anything we put in the air?

Dr. DRYDEN. I don't think so. There are about five different kinds of experiments in it. The apparatus is more or less conventional, not miniaturized in any way whatever.

I think you will inderstand the problems of putting man in space better when we get through with the presentation on that. It is just a question of how you want to proceed.

The CHAIRMAN. We will come back to him. It is much better this way. The members have questions that they want to ask. You can coordinate the hearing much better.

Mr. SISK. The thing that I have been much concerned with, Dr. Dryden, the thing that you touched on a moment ago in answer to the gentleman from Pennsylvania's question, about this idea of how long and how much money are you going to continue to put into research and to experiment before we actually develop a practical apparatus to do the job. Now I think that becomes important because——

Dr. DRYDEN. To do what job, sir?

Mr. SISK. I appreciate now it is a continuing amount of research as you go further and further out but at the same time you mentioned the fact that you would be opposed to anything like a crash program

and probably you are right on that, but at the same time you, I feel, have a rather conservative approach to this.

Dr. DRYDEN. I am not at all opposed to it. I am saying if you give me a budget of $250 million I would not put 100 million of it into this kind of crash program because I think the gamble is that it would be down the drain.

Mr. SISK. The point I am asking you, Dr. Dryden, is this: I realize that in attempting to develop an instrument, for example, a manned space vehicle, there comes a time somewhere where very much of experimentation should be finished and the time comes to put the experiment into orbit. Is that right?

Dr. DRYDEN. This is a matter of words, because what we are talking about is the applied research and development which includes construction of vehicles. I perhaps have not made that clear.

Mr. SISK. Maybe I am not making myself clear. We have before us in another committee, of which I am a member, a remote problem but of similar nature. That has to do with our saline program. Many of us are getting concerned they are going to experiment until doomsday and never build a production plant. This is what I am trying to pin down here. I realize it will be continuing research and continuing improvement but I think we have to look to something besides that and that alone and look to an objective and to strive for that. I agree with my friend from Pennsylvania that I think we should do it on the competitive basis.

Dr. DRYDEN. What we are talking about today includes the practical application of satellites to meteorology, a practical application to communications, the development of a device which could carry a man into space at the end of this program, one man into space, as will be described to you, so that this is not a research program and waiting for research to be finished to do something. Perhaps the term "space science" gives the wrong impression. We regard that as an operational program. It is research in the sense of finding out about the environment of space vehicles, but it is a very large operational program of firing the satellite and making the measurements of conditions in space that anything you put up there has to encounter.

Mr. SISK. The assumption, Dr. Dryden, and I seem to forget from time to time the fact that we keep shooting these grapefruits or basketballs, whatever you want to call them, into the air, and at the same time we get an assumption on some people's part that we are advancing just as rapidly as the Soviets. I would hope that we are getting as much information, but the point is that even if it comes purely from world propaganda we are not doing much of a job in that type of thing.

Dr. DRYDEN. I am trying to confine my remarks about relative position to the knowledge of the environment and not to our relative position on boosters and our ability to put things into space, because we are not progressing as fast as the Soviets in those areas.

Mr. O'BRIEN. Dr. Dryden, you mentioned the possibility of a $100 million gamble and it is not too desirable. But is it not obvious that the Soviets made a very costly gamble which paid off?

Dr. DRYDEN. I don't think it cost them so much since they decided to take their ballistic missile boosters and divert them from their ballistic missile program to gain this effect.

The CHAIRMAN. Do you know they did divert them?

Dr. DRYDEN. Yes.

The CHAIRMAN. Or did they build additional ones?

Dr. DRYDEN. I cannot answer that question, of course.

The CHAIRMAN. There is a difference there.

Dr. DRYDEN. If you build additional ones they can be used either for ballistic missiles or for space. This is one of the nice little problems of the new agency if we get additional boosters built, something then happens internationally and we decide we need those boosters for our military forces instead of space, why, we will be in a little bind for a while.

Mr. O'BRIEN. Do I understand you believe they weakened their military posture in order to launch this satellite?

Dr. DRYDEN. No.

Mr. FORD. Although I am greatly concerned about the problem of a $10 billion deficit in fiscal 1959, if I thought that technically, facility-wise, you could handle more money advantageously the additional burden on the Treasury would not keep me from making more funds available. I have not yet got a clear-cut answer to the question which bothers me the most. If you got more money for more facilities and more people in this program would it have a possible adverse reaction on the military side of the satellites and missiles.

Dr. DRYDEN. I don't know how this would come out in the wash, so to speak, but if there were another 100 or 200 million dollars, what this means is that you could accept some of the many proposals floating around to make these types of gambles with the clear understanding that there was no assurance that they would be successful.

Mr. FORD. Would those additional gambles that would be reflected in more money have a potential adverse impact on our own military missile and satellite program?

Dr. DRYDEN. No, only if you offset it by having some overall ceiling of what you appropriate, some total amount of funds. Now the types of things that you are talking about, the type of things that we are thinking about laying the groundwork for are such things as more ambitious undertakings with regard to the moon. Again, the presentation to follow has some discussion of these points. The other type of project considered is to send a probe in the neighborhood of Mars or Venus or one of the more distant planets. Now the question is whether the state of development of guidance, the communications, all the accessories, are sufficient to warrant this.

There have been much less expensive programs in which much smaller gambles have been taken which ran unsuccessfully. We didn't get communications back, we don't know where the object went or what it did. We fired it in the air but we got no results for the expenditure of money.

Mr. FORD. Would you know 6 months from now when Congress comes back whether it would be a better gamble?

Dr. DRYDEN. I tried to state that this is the money to initiate the program.

The CHAIRMAN. By "gamble" you mean a calculated risk?

Mr. FORD. Yes. If Congress reconvenes could we more intelligently make more money available?

The CHAIRMAN. And from the angle of the agency they would be——

Dr. DRYDEN. You will have a new budget presented to you in January.

The CHAIRMAN. We know that experiments cost money. We know that there will be failures.

Dr. DRYDEN. You will have a new budget before you in January, of course.

Mr. McDONOUGH. It will be judged on what progress you make on this basis?

Dr. DRYDEN. Perhaps this is confusing. The NACA, which is absorbed in this agency, has $101 million which carries on what we call research supporting aeronautics and space in addition to the $242 million under discussion. We think that this is a good amount to start with right now. What I will tell you in January when we come back with the next budget I cannot say at this time.

Mr. BROOKS. May I ask you this question along that line? Is the fact that the Soviets have not sent up any more satellites indicative, in your judgment, of the fact that they feel the program has not paid off?

Dr. DRYDEN. No. Knowing the past history of the Soviets, I would suppose that they are working on some more difficult undertakings.

Mr. BROOKS. Would you judge it would be due to the fact that they are diverting their satellite boosters to intercontinental ballistic missiles?

Dr. DRYDEN. This is speculation on my part. The space program in Russia is run by the scientists in the academy through their institutes. They get their boosters from the military. I would expect that there are the same kind of discussions between the scientists and the military as to how many boosters can be used in the space program and what is the value of the space program. They have had their psychological impact, and I think they will continue the program.

Since the end of the war they have carried out an extremely orderly and logical program. They began by shooting dogs in the air by vertical rockets, and instruments in the air in vertical rockets. There is some evidence that the final satellite that they put up, the last rocket stage, was the identical type of rocket that they had shot in the air hundreds of times before, and the same way with the booster that was used. It has been in their missile program. They went step by step, beginning with the flights to high altitude in the atmosphere right on down the line.

I would expect that they have a program to go further.

Mr. BROOKS. So you would not think, then, this indicates any change in the program on their part which would use all of their thrust for intercontinental ballistic missiles.

Dr. DRYDEN. I don't think they have stopped work on the space program; no.

Mr. NATCHER. Dr. Dryden, as you know, the bill before us at this time provides for an authorization of $47.8 million.

Dr. DRYDEN. For capital facilities.

Mr. NATCHER. As I recall your testimony at the time of the regular hearings, naturally you, like a great deal of other people in this country, were not satisfied with the rate of progress that we had made. Considering the amount that you have testified about, Dr. Dryden, something over $200 million, plus the authorization set forth

in this bill, in your opinion are we progressing at the proper rate at the present time? Are you satisfied in your own mind as to our rate of progress now?

Dr. DRYDEN. We are moving from no space program, or a very small space program, to a program of this magnitude. I think this is a reasonable first step. This is the only thing I can say about it. We have carried on through this interim period, since October 4, 1957, with a program—I have forgotten the numbers—it certainly is considerably less, less than $100 million. I don't remember the exact figure. Now we are proposing to step it up two and a half times. This is starting on a growth curve.

I would hope that the support does not level off at this number for some indefinite period. I would think this would not be a good situation.

Mr. NATCHER. At the present time are you satisfied with our rate of progress? You in your own mind.

Dr. DRYDEN. We have not started. We don't have a nickel. We have not begun. The only program going on now is on the first two charts shown you here, the IGY program, most of which was Vanguard, the ARPA program which consists of 10 or a dozen satellites and lunar probes.

The CHAIRMAN. Mr. Natcher means assuming you get the money.

Dr. DRYDEN. Assuming we get the money we think this would begin a sensible program.

Mr. NATCHER. Yes.

The CHAIRMAN. Mr. O'Sullivan, you may proceed.

Mr. O'SULLIVAN. My next two charts show the proposed program. I call to your attention that we are now speaking about the unmanned satellite part of our program. There will be later presentations with respect to the manned satellites.

The unmanned satellite program and probes. Now considering the information that I have just given you, it looks like this program falls into two major portions. The first portion is built on these three concepts: Payload limitation of between 120 pounds placed into an orbit approximately 300 miles altitude and here is one of the most important points, spin stabilization, if required. That means the satellite itself would require at most nothing more than spin stabilization. That is spinning about its longitudinal axis.

We could perform these experiments which form a logical continuation in building upon the information that we now have and in broadening the base, the range of the experiments that we have thus far performed.

The second part is based on these premises.

The CHAIRMAN. About when will this arrive?

Dr. DRYDEN. Both of these programs are scheduled—this is work scheduled for the appropriations which you are considering right now.

Mr. O'SULLIVAN. Actually the firings would come in a year or 2 years.

That depends on our boosters. The boosters, the potentiality that I spoke of could be available in, as Dr. Dryden said, a year to a year and a half.

Mr. SISK. I understood Dr. Dryden to tell the gentleman from Pennsylvania a little while ago that the 700 or 1,000 pounds was capable——

Dr. DRYDEN. You will recall from recent stories in the press that they are having a little "teething" trouble with the Atlas. If we want additional Atlases for the space program we order them now and we get them 9 months from now. This is the situation.

I say they are here now in the sense that the first Atlas firings are being made. They are having a little teething trouble at the moment. If we want Atlas boosters for the space program we place our order now. We get them in approximately 9 months to a year.

Mr. McDONOUGH. As I understand that, this is the satellite, not the powerplant he is talking about. The powerplant is available if the military will transfer it over to space to shoot this satellite.

Dr. DRYDEN. I think the point is that it is not available tomorrow. It took 8 years or so to develop. This booster is practically here. But if we want some, we order them and it takes 9 months to a year to get them unless you divert them from the scheduled ballistic-missile test firings.

Mr. O'SULLIVAN. The second set of experiments which would be concurrently proceeding are distinguished by these three features: Weights in excess of 200 pounds; orbits in excess of 300 miles; and, here is the important point, including in the satellite a stabilized platform. By stabilized platform I mean a device which holds the attitude of the satellite such that we have a sense of up and down and it is not tumbling head-over-heels as our present satellites, both American and Soviet, are.

These are the types of experiments that it appears would probably come first.

Now the selection of this program has been based upon the proposals, as I mentioned to you before, that have come to us from our scientific community considering what is available in the way of launching systems within the time schedule we are speaking of and trying to build a program within the money that is anticipated for fiscal year 1959, which amount is $64.7 million, of which $13.6 million represents that part of the program which I showed you is in ARPA at the present time.

Dr. DRYDEN. The $13.6 million is the residual financing of the ARPA experiments. The cost of those experiments is far more than $13 million.

Mr. McDONOUGH. Will you explain the atomic clock on that chart?

Mr. O'SULLIVAN. This is an experiment looking toward a vertification of the general theory of relativity of one portion of the theory with an experiment which we have never had the possibility of testing until satellites become available.

Mr. McDONOUGH. What is the galactic light? What do you mean by that?

Mr. O'SULLIVAN. This is light from sources external to our own galaxy, that is the system in which we live. Now it is quite difficult to explain, but it was shown quite some time ago, with not too difficult mathematics, that if one postulates that space continues indefinitely with matter spaced uniformly as we find it around here, then you can show that the intensity of light here should be infinite and should be the same everywhere else. Obviously we find that this is not so. Therefore, we have deduced either something is wrong with the theory or else space runs out or matter runs out in space.

This is aimed at trying to find the answer to that.

Dr. DRYDEN. I think we will reverse the order and take the manned work next. So, Gilruth, will you take over.

Mr. GILRUTH. Gentlemen, you have just heard the portion from Mr. O'Sullivan of our program that deals with the scientific work. I will be followed by Mr. Cortright, who will describe the program which deals with the advanced technology, bigger boosters and higher energy fuels and so on.

I am going to talk about that part of the program that will lead to ultimate manned flight into space. As background to this I would like to review briefly what the general concept is of how these early experiements will be performed, just what the early experiments will consist of. In order to protect the man from the space environment, he will have to be enclosed in a vehicle. This vehicle, as presently conceived, will be a device about 7 feet in diameter and shaped like a cone. This little model here is one concept of what the shape might be.

The man would recline on a couch at the base of this cone. This couch would be carefully fitted to his body and in this position the man can stand much more acceleration than he could in another position. This device will have to be pressure tight in order to contain the breathing atmosphere for the man. It will have to be designed to keep the right temperature for him and there will have to be provision for disposal of waste such as CO_2 (carbon dioxide) and water. There will have to be scientific instrumentation aboard and communication equipment.

This device or one somewhat similar to it will be placed on the front of a ballistic missile. That is, our current ballistic missiles have both the performance to lift this device into orbit and their guidance systems have sufficient accuracy to do this.

This device would then be put into orbit at, say, 120 nautical miles, and it would go in orbit around the earth. Once in orbit, he could not tolerate the device to tumble. This would be horribly confusing to the man and also one other very important reason: when you decide to return to earth from this orbit it is necessary to slow down the satellite.

A relatively small amount of velocity loss, two or three hundred feet per second, is enough to cause the satellite to lose enough altitude from this 120-mile orbit so that it begins to reenter the earth's atmosphere. Once it gets into this atmosphere there is generated an aerodynamic drag which will slow the vehicle down until ultimately it reaches a low speed. At this point, say at 25,000 feet altitude and a low subsonic speed, you would deploy a large parachute which would then lower this device with the man gently to the earth. This is the general concept.

I would like to talk now about some of the mainly technical problems that are in the way of doing this.

First, you have to launch it. The Atlas, for example, has enough performance to put this in orbit and the guidance system is accurate enough, but there is a matter of reliability. You don't want to put a man in a device unless it has a very good chance of working every time.

There are scheduled many Atlas firings in the next year and a half. Reliability is something that comes with practice. It is to be antici-

pated that this degree of reliability will occur as a result of just carrying out the national ballistic missile program.

I said that this device will reenter the atmosphere. Here is a region of a major problem because of two things: First, you have to absorb the heat of reentry. Secondly, the device must be inherently stable so that it does not tumble and so that it does not subject the man to unusual acceleration at higher altitude. So far as reentry heating is concerned, we have a large body of research information already available to draw on.

I would like to touch on some of the experiments that have already been made from which we can draw.

Mr. McDonough. Before you get away from that, tell me what is this cone constructed of?

Mr. Gilruth. Various materials. This flat part here, which is the part that will come in first, this is the heat shield. Now, there are several possibilities of materials that this might be made of. It might be made of beryllium, which is a material that has great capability to absorb heat. It might be made of some ablating material such as perhaps nylon, that in effect vaporizes and forms a shield of gas that prevents so much heat from being carried into the body.

The problem is somewhat similar to the ballistic missile reentry problem. The main difference is that in the manned satellite case, the heat pulse is less intense, but lasts longer.

So, in general, you cannot use exactly the same techniques that you use for the ballistic missile. The upper part of this would be the pressure vessel which presumably would be some material like stainless steel. Outside of this stainless-steel pressure vessel you would probably use a very thin corrugated sheet, both as a meteor shield and also to protect this back part in case it should get tipped and some of the intense heating would be applied on the back part of this device.

You would have to have insulating material inside both from the point of view of sound insulation and heat.

Mr. McDonough. How could he observe anything?

Mr. Gilruth. There will be a window in this thing. This is an important point that I forgot. I think you really owe it to this man to let him look out.

Mr. McDonough. What would be its weight?

Mr. Gilruth. The best estimates, and a number of groups have worked on this, the weight would be of the order of 2,100 or 2,200 pounds. We think we can do it with this. However, it has to go through a complete process of engineering design in order to be sure.

Mr. McDonough. At what speed would he travel in orbit?

Mr. Gilruth. About 25,000 feet a second.

Mr. McDonough. Coming back in the atmosphere what would he be traveling at?

Mr. Gilruth. He would start at this speed, and he would decelerate. This device will decelerate at 10 g., 10 times gravity. This is well within the capability of man to withstand.

Mr. McDonough. He would have communicating instruments for minitrack stations here?

Mr. Gilruth. He would have radio communications with the ground; that is correct.

The Chairman. How long will he remain up there?

Mr. GILRUTH. The current designs—I think for initial flights you would want to limit it to just a few passes around the earth. This makes recovery more simple.

Mr. McDONOUGH. Can he control his reentry?

Mr. GILRUTH. Yes, to some degree. Now in order to reenter you have to fire these rockets that slow the thing down. The point at which you reenter the atmosphere is determined by just where in the orbit you decide to fire these retrorockets.

Mr. FORD. Will he have control against the possibility that took place in one of the Vanguards or Explorers where it went off beyond the orbit.

Mr. GILRUTH. Yes. This is an important part of the whole design. It must be designed, we feel, so that if for some reason it gets part way up during launching and something goes wrong with the boosters, that he can decide to jettison himself from the booster combination and then deploy his parachute so that he can return safely.

This is an important point.

Returning to the stability and heating studies, this chart here consists of 2 photographs which were taken in 1 of the NACA facilities at the Ames Laboratory in California. These are actual photographs taken through a window of a hypersonic tunnel test chamber. The models are illustrated here. They are fired upstream in this test chamber out of a large caliber gun. So if you add the speed of the gun to the speed of the tunnel you get a speed approaching the satellite speed.

From observations such as this—we have a number of windows along this test chamber so that we get successive photographs of the position of this body as it passes down the test section—from an analysis of these photographs you can deduce the degree of stability or the tendency of the shape to oscillate or tumble.

Also from small instruments located in the models the heat input is measured. These instruments measure the temperature and telemeter it to a receiver outside the wind tunnel.

Another technique that is being used in this work is illustrated by this chart where the photograph here on the left shows a test vehicle of the type we have been firing at the Wallops Island station on the Virginia eastern shore. The device under test is this very top bit of the stack here. This is a blunt shape such as on this model, not exactly the same but somewhat like it.

In this stack this first stage rocket is fired and then the second stage rocket and the impetus carries the remaining three stages on up to a very high altitude where, as they turn over, the last three stages are fired in quick succession driving the test body back into the atmosphere to obtain reentry heating conditions.

With the graphs over on the right—I want to illustrate just one point—these are test points. This parameter here indicates the rate of heating. These test points, as you will see, are in reasonably close agreement with this dotted curve which is a theoretical or an analytical method for calculating heating. This indicates that the test results are in good agreement with prediction methods and show that a sound base exists for engineering design of full-scale devices.

Mr. McDONOUGH. You say that is a comparision of velocity with increased temperature?

Mr. GILRUTH. This indicates a rate of heating in British thermal units in square feet per second.

Mr. MCDONOUGH. What does the up and down scale indicate?

Mr. GILRUTH. That is the rate of heating.

Mr. MCDONOUGH. What is your highest point on your theoretical chart?

Mr. GILRUTH. This is a parameter here which indicates the position across the face of the device. As you get over here to the very edge it is sharp, which is a discontinuous point in the calculations.

So this disagreement at the very outside point is not significant.

The lower chart simply indicates that the range of parameters studied by this test, as indicated by these points, is above those encountered in the manned recovery.

The other problem I mention has to do with the stability—the degree of stability of the manned capsule as it reenters the atmosphere. This photograph shows a motion simulator which we have constructed at our Langley laboratory.

The object in the center is a wooden mock-up of the capsule such as a man might ride in. It is suitably gimballed so that motion about all axes can be simulated.

Now, this device is used for studying systems and the man, himself, to determine the effect of these motions on him. The motions are produced by servo-mechanisms that are fed by the inputs from aerodynamic wind tunnels. Tests to date have shown that if you select the right shape for the vehicle the motion is well damped and the frequency of the motion is of the order of one cycle per second which is the airplane order of frequency and should not be troublesome.

Mr. MCDONOUGH. These tests were with a man in the cone?

Mr. GILRUTH. Yes.

Mr. FORD. That is full scale, then?

Mr. GILRUTH. Yes.

Now, this next chart shows the layout and illustrates more clearly just what a device such as this might actually look like. I think it is largely self-explanatory. The couch is shown with the man. This is the pressure vessel which contains the breathing atmosphere. The heat shield for absorbing the heat energy is shown here. This cluster is retrorockets. They are deployed laterally and are fired through a central nozzle. The parachute pack is shown here.

In this concept the man would look outside through a periscope. The little attitude jets are the devices, little gas jets that will be used to stabilize and hold the device steady in its orbit so that it does not tumble.

Mr. MCDONOUGH. How about food on board here? He would not need any food?

Mr. GILRUTH. He would not need much. I think you would put some food on board. I do not know in what form.

Mr. MCDONOUGH. He just has a point of observation that you are talking about. Does he have any instruments to operate himself?

Mr. GILRUTH. This is under discussion as to whether or not the man should have any vital chores to do during the flight or whether the plan should be automatic.

Mr. MCDONOUGH. Just for flight purposes only.

Mr. GILRUTH. At first. Ultimately certainly you would want to use the man's intelligence.

My last chart summarizes the cost of the planned program for fiscal year 1959. The development and construction of model and full-scale capsules for flight experiments, also for test on the centrifuge and for static tests, $6.5 million.

Instrumentation for this model and full-scale flight capsules, $4 million.

Booster systems for 5 model and 2 capsule-scale flights. These would be instrumented and small-animal flights. $19.5 million.

A total of $30 million.

The CHAIRMAN. Are there any further questions?

Thank you very much.

Dr. DRYDEN. Now, the forward-looking program on the components and boosters, Mr. Cortright.

Mr. McDONOUGH. Mr. Gilruth, I did not ask the time schedule on the production here.

Mr. GILRUTH. We visualize that the current funding would carry this program through instrumented flights. It will not include the actual manned flights.

Mr. McDONOUGH. I mean the period when you can shoot this, from this point on how soon before you are ready to shoot the man in the cone?

Mr. GILRUTH. The manned flights would be—it is a guess—a couple of years off at least.

Mr. FULTON. How soon could you shoot the man in a cone for test purposes at some distances that are more than just jumping off a ladder?

Mr. GILRUTH. This might be done much earlier, it might be done perhaps within a year.

Mr. McDONOUGH. That is what I meant.

You can ask Mr. Fulton to volunteer.

Mr. FULTON. I was going to ask Dr. Dryden, we are not going to shoot a woman out of a cannon on one of these tests, are we?

Mr. CORTRIGHT. Gentlemen, the problems we are talking about are those which we can get at immediately or in the near future. The reasons we can do it is because we have inherited a lot of good equipment from the missiles program. Good boosters and good guidance systems.

Now the question we all ask ourselves is: Where do we go from here?

Your questions certainly indicated this was foremost in your mind also.

Where we go from here is going to depend pretty much on what sort of program we set up for research and development on advanced components and techniques. This program must be progressive and well coordinated and of a continuing nature.

We are going to meet with a lot of failures and it is going to seem slow at times.

The program will be largely carried out by contract with private industry and universities. It would be supplemented, however, by research and development in the various laboratories of the NASA and other Government agencies.

I would like also to comment that the program is flexible; it has to be. Any research and development program has to be continually subjected to review and variation, depending on the new information that will be continually coming in.

Now, the areas about which I am talking and which I am going to elaborate on here are propulsion systems, vehicular subsystems, instrumentation, some special vehicles with which we are concerned, and communication and meteorological satellite programs.

I would like to start out by discussing propulsion systems.

One of the most important steps in the propulsion system program is to develop a new booster, one with greater capability and the booster in which we are interested has a capability of from one to one and a half—this booster would have a thrust capability in a single chamber from one to one and a half million pounds. Its capability when utilized with the second and third stage would be to put 40,000 pounds into a 300 mile circular orbit. It could put 10,000 pounds into circumnavigation of the moon and return to orbit around the earth. That same 10,000 pounds could be lowered to the moon's surface without breaking it up and 400 pounds of that could be brought back.

Now, this booster would indeed have great capabilities and we would plan in the research and development phase of it to study the possibility of putting three of them together. When you do that, you can multiply all of these by three. Now, even when you multiply this 1 by 3, we only get 1,200 pounds back from the moon.

You are all interested, again from your questioning, about things that are far out. Well, the man exploring the Moon or another planet has received a lot of attention and we are certainly are going to direct efforts so that will have that capability some day but even three of these together would not permit that. So we have to look for techniques to let us put greater payloads up and bring more than 400 pounds back.

Dr. DRYDEN. May I interrupt your thought for a moment? You perhaps read the announcement on the Air Force contract on the million pound engine. This is the project for which the responsibility is transferred to NASA under this pending transfer from Defense along with other projects. I thought it would be confusing if we talked about the military having a project for a million pound booster and our having a project. It is the same project.

Mr. CORTRIGHT. One way we can up this capability is to cluster these.

Another way is to be a little more sophisticated when we get back to the earth. In other words, we would slow down by atmospheric breaking or dragging through the air rather than carrying a rocket all the way up to the moon and back for slowing down purposes.

Another way, perhaps most potent of all, would be to develop higher energy fuels. If we talk about a fuel like hydrogen and oxygen or hydrogen and fluorine used in all three stages, we can multiply the payload to be returned to earth by 15.

Mr. McDONOUGH. This is not theory, it is real?

Mr. CORTRIGHT. It is real. We have obtained specific impulses, a measure of merit of a rocket, of 360 seconds at the Lewis Laboratory recently. This compares with 250 with current engines, for example. It is a lot better than it sounds. It is better than 2 to 1 again in payload. It is 15 to 1 for this particular mission. It is 3 to 1 for a satellite orbit around the earth.

We are not suggesting that the first thing we shoot at is high energy fuel in all stages because these fuels are difficult to work with and there is a lot of research that has to take place.

We start out by developing upper stages but the point I am trying to make is if we develop this and prepare to cluster them and if we develop the high energy fuels for the later stages and if we use atmospheric braking we definitely can develop the capability to bring not 400 pounds but in excess of 10,000 pounds back from the moon. This is what is going to be required to do that job with any safety.

Mr. McDONOUGH. If you took this rocket engine with the existing practical fuels we are now using, what could you do?

Mr. CORTRIGHT. That is what this chart is.

Mr. McDONOUGH. You would multiply it four times, you say——

Mr. CORTRIGHT. Well, if we put 4 of those together we multiply it by 4.

Mr. McDONOUGH. Do you mean to say that that one engine you have designed there is 1.5 million pounds?

Mr. CORTRIGHT. It is a maximum of that. It would be from a million to a million and a half. It is in the study phase now. It would develop the higher thrust as it was experimented with.

Mr. FORD. You are talking about liquid and not solid fuel?

Mr. CORTRIGHT. Yes. I am talking about a hydrocarbon-oxygen rocket.

Mr. FORD. Does the possibility of solid fuels offer any improvement on that or not?

Mr. CORTRIGHT. That is a debatable point. I do not think so personally. We have a long way to go to get solid fuel rockets into this thrust category but we have a program to support the development of better solid fuel rockets. I think at first there are lots of ways you can improve solids. You can get better case designs. You can lighten up the nozzles and make them give jet control with a more simple mechanism. You can develop better solid propellants. There are quite a few very interesting possibilities we see there.

Dr. DRYDEN. They are using solid propellants in upper stages.

Mr. CORTRIGHT. Yes. There are problems associated with grain size which have to be solved before you can talk about large sizes, unless you talk about clustering a dozen or two together. It is in the picture but we would not begin working on solid rockets of this size right away.

Mr. McDONOUGH. This next line means it would take some years to develop this.

Mr. CORTRIGHT. It might take 5 to 6 years.

Mr. McDONOUGH. What would speed it up faster, the propulsion fuel or the design?

Mr. CORTRIGHT. This year we have enough money in the budget to get this rolling pretty well. Where the money really starts to be poured in is when you start cutting hardware and developing the engine into a production item.

The first things that have to be done are to develop the combustion chamber, develop the pumps. The money builds up. It is a growth curve. It starts pretty fast once you start making some progress. The whole engine might cost a quarter of a billion dollars before it is a dependable production item.

To get on with this high energy propellant program, this is the program which we would support this year. There are three fuels which are of interest: hydrogen and fluorine, hydrogen and oxygen, and hydrazine and fluorine. The size rockets we need for second and

third stages are indicated here. So there is a proposed a research and development contract for 12- and 8-thousand-pound units using this fuel, 20 and 100 thousand pounds with this one. Actually this is research being conducted in the NACA laboratories at the present time.

Now, the work for this year primarily will be to develop the combustion chambers so that they run without oscillations, they can cool with their own fuel flow over the outside surface, they do not burn out, the pumps work, you can handle the fuel. There are very serious handling problems with fluorine, for example. We do not know which of the fuels will pan out to have the most use. These two fuels have higher impulse. This one is more dense. So the tanks would be smaller and lighter.

Eventually the greatest potential would be in these two fuels (hydrogen-oxygen and hydrogen-fluorine). They are also probably the furtherest away.

Mr. McDONOUGH. Does the H_2F_2 indicate the formula combination?

Mr. CORTRIGHT. These are the two elements put together.

Dr. DRYDEN. Hydrogen and fluorine, two atoms to a molecule of each.

Mr. CORTRIGHT. If we want to talk about getting greater payloads for initial gross weight which is a measure of efficiency of rockets we have to consider the nuclear rocket. It is in the picture.

Now, the nuclear rocket program, as has been pointed out earlier today, is being carried out by the AEC and the Air Force and our funds include moneys to continue to support that portion which was formerly supported by the Air Force.

I have plotted a term "specific impulse," which may not be familiar to you. It essentially is a measure of the pounds of thrust you can get out per pound of fuel per second. It is what you do with your fuel essentially. The fuel, of course, is uranium but hydrogen is the propellent and the higher the temperature to which you heat hydrogen the faster it comes out and the more thrust you get per pound of propellent expended. This will be limited by the melting point of the fuel elements in this type of rocket which is the type that is being worked on right now. If we limit that temperature to the melting point of hafnium carbide, which is one of the highest, we can get impulses of around 1,200 seconds.

Remember, we have a 15 to 1 advantage by getting impulses from 250 to 360. Now we are talking of getting it up in the neighborhood of 1,000. Certainly we would not run to the melting point. We would not use a hafnium carbide fuel element right away. Some of the fuel elements down here I do not think I should go into in an open meeting. We still think we are going to get a specific impulse of 800 or 900, which is very good.

Over here I have indicated the sort of thing which has to be supported by research and development. This is a gaseous reactor. Here the propellant is brought in in such a way as to keep the high temperature fluid away from the wall so that you are no longer limited in principle by the melting point of the wall. Then we can talk about very high temperatures if we are smart enough to diffuse the propellant through the fuel and extract it and leave the fuel in there or most of it. This is a dream at the moment. And there are various schemes all of which run into serious theoretical difficulties. But it must be supported.

I want to say a word about electric propulsion, again because you have shown so much interest in the far future system.

Electric propulsion has gotten a lot of publicity because it has the virtue of very high impulses, higher than the nuclear rocket unless you get into that gaseous type. But it is not near.

There is a tremendous amount of work to be done before we can put together a working system.

Electric propulsion systems utilize reactors for the heat source, perhaps solar energy and maybe someday nuclear fusion. Then they use conventional turbo-electrical equipment to generate electricity and that electricity is used to accelerate propellent. It can be any element. In fact, it can use human waste as a propellent in such a case.

Now, we are conducting a lot of research in our laboratories on the components of such a system and we are going to support outside research also so that when the day comes that we get the boosters to put these big components up and assemble them they will be ready to go.

I just thought that word would be of interest to you because I am trying to place this in the time picture.

When you get to talking about huge and sophisticated systems like that, you might be inclined to overlook the tremendous amount of work which has to be done on subsystems. Subsystems include such things as auxiliary power supplies, guidance and control equipment, communications equipment, and that sort of thing. For example, in guidance here: It has already been mentioned that we have inherited some very good guidance equipment, from the missile program, to take care of this initial part of the flight. We can aim this thing for an advanced mission such as to Mars here with fairly good accuracy but good accuracy can still put you a very long distance from Mars when you get there.

So we have to start developing midcourse guidance equipment. It will include equipment to take optical sightings of the Earth, Sun, Moon, planets, and stars, and radio fixes on the same objects.

When the vehicle arrives at the destination, which might be Mars or the Earth, on the way back you have to have very precise terminal guidance because you have designed your whole mission around getting in a precise orbit. You might not have a whole lot of extra fuel to correct for missing your orbit by too much.

Then if you want to drag through the atmosphere here for slowing down that would call for much more precision. On the path as you are flying you will have to, at least during times when you are taking sightings and navigating, you will have to be oriented. In other words, where is up? If there is an up out there. So this takes power, it takes instruments to detect directions and electrical power to position the vehicle relative to the direction.

During this whole flight we will have to be in continuous communication with the vehicle. The obvious reason is that the vehicle will be picking up information all the way on the particles and radiation which are encountered.

Another important reason which one might at first overlook is to monitor the equipment. If something goes wrong, you have to know what it is so that you do not repeat the same mistakes.

The burdens of such communications on communications equipment and power supplies are very great. There has to be a major program on the many——

Mr. McDONOUGH. As I understand it, you do not have a midcourse guidance system worked out at the present time.

Mr. CORTRIGHT. That is correct.

Mr. McDONOUGH. You do have the initial guidance system from the satellite?

Mr. CORTRIGHT. The ICBM systems carried in later stages turned out to be quite good for many of these missions. They might put you, for example, within several diameters of the target as an order of magnitude.

Dr. DRYDEN. He said "might."

Mr. CORTRIGHT. I said "might". This is a debatable point. The subprograms under communications include developing large antennas which can be erected and pointed very accurately. The system to aim these antennas: High sensitivity receivers, both in the vehicle to take commands from the earth and on the earth to minimize the burden on the vehicle. The transmitter size and weights have to be kept small. The power suppliers have to be kept light and given long life and interference with radio propagation has to be studied.

Now, on this start, for example, reducing requirements on the power supply one way is to use bigger antennas. This is an engineering problem, largely.

Another way, which is also engineering actually, is to develop coding techniques where you take something like a television picture when you get there and if you send that back just as you take it, continuous transmission, it might require 10 megawatts of power, whereas if you code that and send it back in a simple teletype signal, it could be reduced down by a factor of a hundred or more. It would take longer, however.

Now, in support of this program and others we are going to have to develop other special vehicles. I think I will make this chart brief because of time here, but one of the special vehicles is a stabilized platform—it has been referred to already—we would use for entry problems, rendezvous in space, biological and subsystem experiments, meteorological, geophysical, and astronomical studies.

These last two might require a tremendous order of precision of stabilization.

This system must be worked on immediately. There are 2 types that are going to be needed, at least 2. One would be a system to stabilize something in the 100 to 300 pounds, which might be our workhorse-type satellite for experimentation. Another would be greater than 2,000 pounds which would be suitable for mounting something like a telescope.

Now, there are two areas at least where we can start, I think, real gain, practical utility from satellites. These are meteorology and communications.

To take meteorology first: Its purpose, I think, is obvious; that is, to understand and predict the world's weather for the benefit of all of us, civilian and military. The measurements which must be taken include cloud cover, not just how much of the ground it covers but what the clouds are, how thick they are, how many layers, and so forth. Wind direction and velocities, moisture and ozone content,

the spectrum of reflected and absorbed infrared radiation from the sun. This is the purpose essentially that forces our weather to do certain things.

We are not going to get all these things this year but a joint group, the NACA working with the Defense Department, ARPA group, has concluded that certain things can be done right away and of these things the most interesting are to get a television camera up and start bringing back television pictures of cloud cover on the lighted side of the earth, the illuminated side. Some of the infrared sensors here can eventually discover cloud cover at night.

In the communications area—I am not talking about communicating with the vehicle any more, I am talking about one point on the earth communicating with another—right now we have to go through a system of wires or for high frequency communication sometimes we use relay stations, none of them going over the horizon. These beams are chopped off by the horizon. But if we can reflect it by an object in space or rebroadcast it from that object, we get around the curvature of the earth problem. We have a sizable program at least to support this vehicle in the near future. For example, before the end of 1959 or perhaps early 1960, we hope to get a 100-foot sphere or reflector into orbit. We also will undertake immediately the feasibility and design studies for other reflectors which are shaped in such a way as to focus the energy that is impinged upon it.

Lastly, and very briefly, there are different ways of rebroadcasting this. You can send it out immediately or you can store it on tape of magnetic or electrostatic variety and broadcast it later. You can talk of 22,000-mile orbits where the vehicle stays overhead all the time. All these things would be subject to design study immediately.

Now, the money which is allocated to do these jobs, get them well underway at least, would be $30 million on propulsion systems, $28.5 million on the subsystems I was talking about, $7 million on special instrumentation, $16.5 million on special vehicles, such as the stabilized platform, and one type I did not mention you would probably be interested in is the types of vehicles which are fired merely to test a piece of equipment that might have no scientific end in themselves. We are going to have to expect quite a bit of this.

Lastly, $10.5 million for communication and meteorological satellites.

Thank you.

Mr. McDonough. On those items, are estimated amounts to carry out your program and they will, as you said, in the beginning, to be awarded to private industry to develop for you? You will outline the specification of research and basic program of what you want and you will go to private industry to do this job?

Mr. Cortright. A major portion of this money will be so spent. Some of this will be spent to support in-house work.

Mr. McDonough. How much will be in-house?

Mr. Cortright. It is a difficult question because the programs are now being drawn up in detail.

Dr. Dryden. We have a number in the book here. Roughly, in the space technology area, $12,950,000 through Government agencies, $46.8 million nongovernmental agencies. In other words, we are to use the facilities of other governmental agencies. For example, not going to develop a new crew for the firing of boosters.

If it is the Thor, the same people firing Thors now will fire them and they will do it at Cape Canaveral. If it is Jupiter or Juno, the group at Redstone will get this problem and will fire at Cape Canaveral.

Mr. FORD. If you get this communications sphere up and we use it, can some other country make use of it as well?

Dr. DRYDEN. Anybody.

Mr. CORTRIGHT. The types that have to be aimed, that might not be true because we would have the code which would permit that to be aimed; we could program it or direct it by command from the ground.

Dr. DRYDEN. It is like a mirror; anybody can look into it without interfering with anybody else. This has a certain psychological value at the present moment. We are interested in peaceful purposes for satellites. Incidentally, this sphere will also be readily visible.

Mr. CORTRIGHT. Also, the meteorological satellite has implications beyond benefit to ourselves. We will be getting cloud covers over other countries and we can relay that information to them directly, if we so desire, from the vehicle.

Mr. FORD. One that would be exclusively for our benefit we are working on?

Mr. CORTRIGHT. In communications?

Mr. FORD. Yes.

Mr. CORTRIGHT. Yes.

Mr. BROOKS. Now your $92 million will be devoted to advanced components and techniques. Will that all be devoted to the satellite program?

Mr. CORTRIGHT. No, sir. Space science.

Dr. DRYDEN. Space vehicles generally.

Mr. BROOKS. How much is being devoted to the satellite?

Mr. CORTRIGHT. There might only be 3 or 4 vehicles launched in this whole program. This is largely laboratory.

Mr. BROOKS. So it is a general scientific program and not the satellite program.

Mr. CORTRIGHT. This is to develop the equipment which we will be using several years from now.

Mr. BROOKS. The advances you make will be used for the satellite program or any other program that is needed?

Dr. DRYDEN. That is right.

Mr. Chairman, this is a very long prelude to the matter that is before you, which is the authorization bill for $47.8 million in facilities. There are three items. I had mentioned that the firings of large satellites by the new agency will probably be done by the same people who are now firing satellites at Cape Canaveral and at Camp Cooke. The NACA has operated, for 13 years, at Wallops Island, Va., a small range for making experimental measurements by means of rockets. We are proposing to spend $24.5 million to improve the facilities at Wallops Island so that a great deal of the component tests can be done there. I have used the analogy in presenting this matter in various places that we do not want to tie up the enormously complicated and expensive range at Cape Canaveral for some job that is readily done somewhere else without tying up those large facilities, just as you do not use a 10-ton truck to carry 10-pound packages around town. So we are proposing to put this money into Wallops Island. It consists primarily of putting the housekeeping facilit-

that we now have on the island onto the mainland so that, for example, if we wish to work with hydrogen and fluorine we can do it in some safety. You have seen a picture of the five-stage rockets that we are now firing by which we have approached satellite speeds and the normal development of that experimental program will result in satellite speeds in a very short time.

You have before you, I believe, a booklet which breaks this down in quite considerable detail so far as Wallops Island is concerned. The breakdown is on page 15.

This does involve the acquisition of some land on the mainland, purchasing some marshland which lies between the mainland and Wallops Island, so as to control, isolate the experiments and to take title to an island just to the south which is under water every time there is a big storm, just to keep the camping parties and others from getting into unsafe positions

Mr. BROOKS. Doctor, if I mak ask you, generally speaking, where is Wallops Island?

Mr. DRYDEN. Just below the naval station of Chincoteague or the famous island where the wild ponies are, on the eastern shore of Virginia.

Mr. BROOKS. I saw that in the paper this morning.

Dr. DRYDEN. We do not wish to make generally available this map of the exact area that we have in mind because we have not, of course, any title to the land yet. We do not want to run up the market too greatly by giving the exact location.

There is a total of $600,000 in there for land acquisition; $6,182,500 for facilities on the mainland; $4,680,000 for two launching pads and the control station on the island: $537,500 design and engineering services, and $12,500,000 for instrumentation systems.

In our earlier work we started with an old wartime radar. Until a few years ago this is all we had. Now as speeds get higher and higher the distance traveled gets greater and requires better radar. So we did get recently a tracking radar of the type now used at Cape Canaveral.

For space vehicle work we are going to need still longer ranges to be able to track our models to further distances out in the ocean. This provides for the instrumentation part

In addition, at present we make installations of telemeter receivers on naval vessels. It will be necessary to get instrumentation of greater capability down range, either on ships or perhaps elsewhere.

The total in the Wallops Island expansion of facilities is $24,500,000.

The second item is the space projects center in the vicinity of Washington, D. C. It is not within the city of Washington but on Government land nearby. Again I will tell you privately the location that is under consideration but would rather not state it here. I think it will probably be released fairly soon anyway. [EDITOR'S NOTE.—It has since been announced as to be located at Beltsville, Md.]

We feel that it is very essential to separate the management of this work from the research work at the laboratories.

This center will include project control, the data reduction, and the gathering of the scientific data. We feel that the management of such a large contract research program requires an ease of liaison with AEC, the Weather Bureau, and other establishments whose headquarters are in the Washington area, with the National Science Foundation, National Academy of Science, universities, and the scientific community.

Most industries maintain Washington representatives and it is very convenient to have very easy liaison there because a large portion of the program is going to be by contract with industry.

We think that the Center ought to be served by good transportation, near an airline terminal which has some frequency of service to various parts of the country.

Although we have looked at locations at our laboratories, we came to the conclusion that the weight of these factors was such that the center ought to be somewhere close by, but not actually in the city of Washington.

This sum covers the erection of two buildings.

Now, the third item, equipment and instrumentation, refers to the general tracking of satellites. We will begin by taking over the present network of the IGY, which has certain stations in South America and other parts of the world. We will take over the Vanguard computing center down on Pennsylvania Avenue, and we will build on that. We will make use of the optical stations which are operated under contract by the Smithsonian. By building on that foundation with improved equipment, we will build up the necessary worldwide tracking network. I mean there will be stations in other countries as well as in this country.

I might tell you that the discussions so far with the Department of Defense have led to the concept that the Department of Defense will operate the surveillance network necessary to keep track of satellites, distingnish them from ballistic missiles or other objects as a part of the defense system of the country.

Mr. McDonough. You mean at a tracking station you will have both civilian and military?

Dr. Dryden. I was going to say that our scientific equipment will in most cases be located on the same stations so that we do not have additional housekeeping logistics. We will use their communications network but the apparatus which takes the scientific data from the satellites would be under the control of the NASA and we would not assume the task of keeping track of objects in the sky which Defense has to do anyway for the defense of the country.

Mr. McDonough. Do we own the real estate at these minitrack stations around the world in the foreign countries?

Dr. Dryden. At present in South America, for example, they are operated under agreements and one of the jobs now pressing on us is to get new agreements for continuation.

At present the stations are in many cases operated by personnel of the Armed Forces. We would hope to work out arrangements with local scientists, where there are any, to have a mixed group of civilians, so that the country itself has some stake in the operation.

We think this is a sounder basis for a longer term operation than purely a military, temporary group stationed there.

Mr. McDonough. How many minitrack stations do we have, total number?

Dr. Dryden. Twelve have been established, including those in this country, South America and across the ocean.

Mr. McDonough. Do they operate with about the same personnel in each case? Is the operation similar in every instance or is it different?

Dr. DRYDEN. It is different. I do not know specifically about the minitrack but in the case of the optical stations we have occasionally furnished the telescope for observing satellites. The apparatus has been loaned to the local observatory. The scientists there are glad to participate in this kind of program.

So the arrangements are going to differ from country to country.

Mr. McDONOUGH. Your item here for $15,550,000 will take all of those over.

Dr. DRYDEN. That is correct. This is a capital item for improving the existing equipment and stations; $9 million is for extension of the minitrack and optical network capabilities including improveing th existing stations and providing two more.

The two more are needed for satellites in polar orbits. The present minitrack network is set up for satellites that are launched from Cape Canaveral. From Camp Cooke you can fire into polar orbits.

Then you need some stations farther north.

Mr. BROOKS. Part of this has been handled in the past under the Defense program?

Dr. DRYDEN. No; the IGY network was set up, in part at least, major part, by appropriations to the National Science Foundation for the International Geophysical Year, which terminates at the end of 1958. This is why I say we have an urgent job to get some agreements so that the tracking continues and does not fold up.

Mr. BROOKS. You will take it over?

Dr. DRYDEN. We will take it over.

Mr. BROOKS. You will need the money this year, will you not?

Dr. DRYDEN. It is financed until, I think, the end of this calendar year. We have money in here. It is not set out as a separate item.

The CHAIRMAN. What is that $101 million carryover? What can you use that for?

Dr. DRYDEN. That is to carry on the functions that have hitherto been carried on by the National Advisory Committee for Aeronautics. It is what we call the research branch of the Space Administration doing work which supports both aeronautics and space.

The CHAIRMAN. That is in addition?

Dr. DRYDEN. This is in addition to the money you see here.

The CHAIRMAN. So you have $242 million plus that?

Dr. DRYDEN. We will have a total of $343 million.

Mr. BROOKS. What are you going to do after the first of the year for money to operate these minitrack stations?

Dr. DRYDEN. There is sufficient money included here to do it. They are operated, of course, in connection with projects.

Mr. BROOKS. You mean by transfer because this is an authorization, is it not?

Dr. DRYDEN. In the appropriation bill; this committee is considering only the authorization for the capital items over $250,000 as required by the act.

Mr. FORD. How realistic is your land acquisition cost on this project down at Wallops Island?

Dr. DRYDEN. Very much so. Again I would rather not discuss this in open session because it might make our dealings difficult. Some of it is very low-cost land. The marshland is very little. The island is not worth a whole lot. It is higher than marsh. The mainland property is farm property.

The CHAIRMAN. What about this space projects center? Does that mean a new building?

Dr. DRYDEN. This includes two new buildings in the vicinity of Washington.

The CHAIRMAN. What is the estimated cost of the two main buildings?

Mr. ULMER. The space projects building will cost $2,020,000; the research project laboratory, $1,045,000.

The CHAIRMAN. Will that be on a competitive bid basis?

Mr. ULMER. Most of this will.

The CHAIRMAN. I mean the buildings.

Mr. ULMER. The buildings; yes, sir.

The CHAIRMAN. In other words, it will be the lowest responsible bidder and anybody can bid?

Mr. ULMER. Yes, sir. That has been the practice of NACA for many years. We intend to continue that in this construction program.

The CHAIRMAN. What personnel do you expect to have there?

Dr. DRYDEN. 640 at this particular location.

Mr. SISK. Dr. Dryden, you mentioned a while ago about the reason for the location of the Space Projects Center.

The CHAIRMAN. May I ask one more question? That will be the headquarters of the space work?

Dr. DRYDEN. We still will be located in downtown Washington as far as the general headquarters of NASA. This will be the field station of the branch of the organization that spends this $242 million.

Mr. SISK. That leads to a question I had in mind because a little while ago Dr. Dryden mentioned the fact that they did not want to build this in connection with a laboratory, but I notice here in the breakdown you still show something over a million dollars for an additional research laboratory.

Dr. DRYDEN. When previously discussing the site of the center I used the word "laboratory" in the sense of a location, Langley Field, Cleveland, or Moffett Field.

Mr. SISK. I did not mean to be critical. I know a while ago we were discussing it, in fact I believe the gentleman from Pennsylvania inquired about this and you felt it should be a separate location.

Dr. DRYDEN. We will have to start actually—of course, we cannot build this building in a few weeks. We will start the work of the center at Langley Laboratory temporarily. We want to keep this program moving. We do not want to sit around and wait until a building is built before you get things underway.

Mr. FORD. Are you going to have a housing problem with the expansion of the Wallops Island operation?

Dr. DRYDEN. No, I do not think so.

Mr. FORD. I mean housing problem for the people who will work there.

Dr. DRYDEN. I do not think so. As a matter of fact, it is not so much a question of greatly increased personnel as it is of physical equipment.

Mr. ULMER. At the present time there are about a hundred people stationed at Wallops Island permanently.

Mr. FORD. How big an increase will there be?

Mr. ULMER. There will be very little increase there. It will be mostly increase in capability of the facilities.

Mr. McDONOUGH. The largest number of people will be located, you said, 640 a moment ago.

Dr. DRYDEN. 640 at this Space Projects Center near Washington.

Mr. BROOKS. They will all be new people?

Dr. DRYDEN. We are an existing organization. The way you start this is a combination of robbing the old organization of people plus new people.

Mr. BROOKS. There will be new jobs.

Dr. DRYDEN. That is right. There are 640 new jobs of all types.

The CHAIRMAN. Of course, we have had no experience on that.

Dr. DEMBLING. Mr. Chairman, Mr. Sisk asked why the location at the site that was picked. We discussed earlier the reasons for picking the vicinity of Washington.

Mr. SISK. I think that had been made fairly clear, and I have no particular concern about that. The question I had in mind was the reference to a statement a while ago and I had understood from Dr. Dryden that you would have the laboratory work done completely separate and apart from the so-called administrative headquarters. That is where I had misunderstood.

Dr. DRYDEN. I use "laboratory" in the sense of location of Langley Field, Va., Cleveland, or Moffett Field, Calif. This is where we now have stations.

The CHAIRMAN. What about this allowance of 5 percent?

Mr. ULMER. This is a standard provision which has been carried in our construction authorizing legislation for several years. It merely allows for adjustments between the amounts specified for location if the bids come up higher in one place and lower in another.

The CHAIRMAN. I just wanted that for the record, that is all. I understood what it was.

Mr. ULMER. It gives us a little flexibility that we do need.

The CHAIRMAN. But the total amount is not exceeded?

Mr. ULMER. That is right.

Mr. McDONOUGH. Dr. Dryden, can you estimate now what your personnel will be under NASA?

Dr. DRYDEN. Yes, sir. Estimate is 800 people at the end of the year.

Mr. ULMER. Our NACA staff will reach about 8,200 at the end of this year plus 800 we are requesting here which will bring us to about 9,000 at the end of 1959.

Mr. McDONOUGH. That is nationwide?

Dr. DRYDEN. Yes, sir.

The CHAIRMAN. Any further questions?

Will the Space Administration have to handle international relationships now?

Dr. DRYDEN. It is not clear how extensive. We certainly are going to be doing such things as setting up a liaison group at Canaveral. I mentioned these South American stations.

Mr. BROOKS. You will have the space center in operation about when?

Dr. DRYDEN. About 16 months. Temporarily that will be located at Langley.

Mr. SISK. I have a couple questions on the Wallops Island request, that is, the money there. As I understand, you say you are not increasing the personnel out there; is that correct?

Dr. DRYDEN. Not substantially. I think you should understand one detail about that. We have usually not had at Wallops what you might call the project people. They will probably be located at this center, management center. They go down as required. So we do not attempt to make Wallops Island a completely independent operation from the rest of the agency.

Mr. SISK. My reason for asking that, and I notice some of the items there, for example, this new causeway apparently that you plan on constructing out there, $2,300,000, and if there are no new people going out——

Dr. DRYDEN. At present we run a ferryboat across the channel that has to be dredged out every few years.

Mr. SISK. I have no objection to the money that is needed but I was curious in view of the fact that there is no increase in personnel.

The CHAIRMAN. Is this a direct connection between the mainland and the island?

Dr. DRYDEN. Yes; the ferryboat cannot carry anything very heavy. It is also a matter of transporting things.

The CHAIRMAN. In addition to the island activities you will have mainland activities?

Dr. DRYDEN. All of the housekeeping people are on the mainland.

The CHAIRMAN. You will have activities on the mainland also?

Dr. DRYDEN. That is right. Actually the additional radar equipment would be located there.

The CHAIRMAN. Now, the ferry is used probably to go to work and to go back to the mainland but now this will be a continuity of activity during the business day?

Dr. DRYDEN. The island can be cleared of all people so that if you do hazardous things there are no people around.

At present all of those at work now work on the island.

The CHAIRMAN. Does anybody live on the island at the present time?

Dr. DRYDEN. No; we own the island.

Mr. SISK. How long is this causeway?

Dr. DRYDEN. Three miles.

Dr. DEMBLING. The island is primarily used as a launching site in terms of whenever there have to be firings people go over there and use it. That is why there is not much of an increase in the number of people that will be stationed permanently there.

We feel there is no necessity of keeping many people there permanently. If a group from our Langley Laboratory have to fire something, they go over there. If a group from our Lewis Laboratory have to fire something they go over there and fire it and then they return to their laboratory.

The causeway primarily is going to be used to transport some of the large heavy equipment which we cannot get over through the marshland or cannot get over through use of the ferry.

The CHAIRMAN. In other words, it is a road.

Dr. DEMBLING. That is right.

Mr. SISK. I was curious as to the necessity of the bridge in view of no additional people.

Mr. DRYDEN. The bridge is over this marshland. The navigable channel runs down through it.

Mr. McDONOUGH. How far is this from Washington?

Dr. DRYDEN. It is a little over 100 miles, across over Bay Bridge.

Mr. McDONOUGH. Will the causeway be a private entry?

Dr. DRYDEN. Entirely under our control. It ends in the area of the mainland that is fenced and controlled by us.

Mr. McDONOUGH. It will never be part of any system of highway in the State of Virginia?

Dr. DRYDEN. No.

The CHAIRMAN. Any further questions? If not, thank you very much, gentlemen.

The hearings are closed.

Any questions any member wants to ask Dr. Dryden and those accompanying him in executive session?

Dr. DEMBLING. There are two items that came up I might indicate, that was the location of the Space Center—I have sent a note around—and consideration of the amount of money involved in the acquisition of land.

The CHAIRMAN. I did not know whether you might want to give us some inside information other than what we accidentally read in the newspapers. That is the most information I get from world affairs.

Dr. DRYDEN. Yes; can we clear the room?

I will talk about the moon shots.

(Whereupon, at 5 p. m., the committee proceeded in executive session.)

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